

## CLAIMS

1           1. In a plurality of intermediate network devices having a plurality of ports for  
2 forwarding network messages within a bridged network having a root, the plurality of  
3 intermediate network devices organized as a stack, each intermediate network device  
4 having a stack port for use in communicating with the other network devices of the stack,  
5 a method for efficiently transitioning the ports among a plurality of spanning tree proto-  
6 col (STP) states, the method comprising the steps of:

7           executing the STP at each intermediate network device of the stack so as to assign  
8 the stack port of each device to either a Root Port Role or a Designated Port Role, and to  
9 assign a non-stack port at single device of the stack to the Root Port Role;

10           transitioning the ports assigned to the Root Port Role and the Designated Port  
11 Role to a forwarding STP state;

12           designating all non-stack ports at the devices of the stack that provide connec-  
13 tivity to the root, other than the non-stack port assigned to the Root Port Role, as Alter-  
14 nate Stack Root Ports;

15           transitioning the Alternate Stack Root Ports to a discarding STP state; and

16           in response to a failure at the non-stack port assigned to the Root Port Role, tran-  
17 sitioning a selected one of the Alternate Stack Root Ports from the discarding STP state  
18 directly to the forwarding STP state.

1           2. The method of claim 1 wherein

2           each Alternate Stack Root Port has a respective cost to the root; and

3           the selected one of the Alternate Stack Root Ports that is transitioned to the for-  
4 warding STP state is the Alternate Stack Root Port whose cost to the root is lowest.

1           3. The method of claim 2 further comprising the step of, in response to the failure  
2 at the non-stack port assigned to the Root Port Role, generating and issuing, from one or  
3 more source devices of the stack for receipt by one or more other devices of the stack,  
4 one or more bridge protocol data unit (BPDU) messages proposing to transition a given  
5 Alternate Stack Root Port of the device to the forwarding STP state.

1           4. The method of claim 3 further comprising the step generating and issuing, in  
2 response to the proposal BPDU message, one or more Rapid Transition Acknowledge-  
3 ment messages to the source device agreeing with the source device's proposal to transi-  
4 tion the given Alternate Stack Root Port to the forwarding STP state.

1           5. The method of claim 4 further comprising the step of transitioning the given  
2 Alternate Stack Root Port of the source device from the discarding STP state directly to  
3 the forwarding STP state, without passing through any intermediary states, provided that  
4 the source device receives a Rapid Transition Acknowledgement message from each  
5 other member of the stack.

1           6. The method of claim 1 wherein the spanning tree protocol is one of the IEEE  
2 Std 802.1w-1w-2001 and the IEEE Std. 802.1s-2002 specification standards.

1           7. The method of claim 1 further comprising the step of associating each stack  
2 port with a port cost of zero, such that the stack port of each device is assigned to either a  
3 Root Port Role or a Designated Port Role.

1           8. The method of claim 1 further comprising the step of monitoring which inter-  
2 mediate network devices are organized as the stack.

1           9. The method of claim 8 wherein the step of monitoring comprises the step of  
2 periodically exchanging Discovery Hello messages among the intermediate network de-  
3 vices organized as the stack.

1           10. An intermediate network device configured to forward network messages  
2 within a bridged network, the intermediate network device comprising:  
3           a plurality of ports for connecting the device to one or more network entities;  
4           at least one stack port for connecting the device to one or more other intermediate  
5 network devices that cooperate to form a stack;

6 a port role selection state machine configured to assign roles to the ports;  
7 a port transition state machine configured to transition the ports among a plurality  
8 of spanning tree protocol (STP) states depending on the assigned roles, wherein  
9 the port role selection state machine is configured and arranged to assign the stack  
10 port to one of a Root Port Role or a Designated Port Role, and  
11 the port transition state machine is configured and arranged to transition those  
12 ports that are assigned to the Root Port Role or to the Designated Port Role to a forward-  
13 ing spanning tree port state.

1 11. The intermediate network device of claim 10 further comprising a message  
2 generator configured and arranged periodically to issue a Discovery Hello message from  
3 the at least one stack port, signaling that the intermediate network device is part of the  
4 stack.

1 12. The intermediate network device of claim 11 further comprising a neighbor  
2 discovery engine configured and arranged to monitor Discovery Hello messages received  
3 from the other intermediate network devices that form the stack, and to designate the  
4 other intermediate network devices from which a Discovery Hello message is received as  
5 members of the stack.

1 13. The intermediate network device of 10 further comprising  
2 a spanning tree protocol entity configured and arranged to elect a root of the  
3 bridged network; and  
4 a cross-stack rapid transition engine configured and arranged to issue one or more  
5 Rapid Transition Acknowledgment messages to a given intermediate network device that  
6 forms the stack and from which a proposal Bridge Protocol Data Unit (BPDU) message is  
7 received representing a better path to the root.

1 15. In an intermediate network device having a plurality of ports for forwarding  
2 network messages within a bridged network, and a stack port for communicating with  
3 one or more other intermediate network devices that together form a stack, a method for

4 efficiently transitioning the ports among a plurality of spanning tree protocol (STP)  
5 states, the method comprising the steps of:  
6       executing the STP so as to assign the stack port to a Root Port Role;  
7       transitioning the stack port, which has been assigned to the Root Port Role, to a  
8 forwarding STP state;  
9       designating all non-stack ports that provide connectivity to the root as Alternate  
10 Stack Root Ports;  
11       transitioning the Alternate Stack Root Ports to a discarding STP state; and  
12       in response to receiving from a source intermediate network device a proposal  
13 Bridge Protocol Data Unit (BPDU) message on the stack port that specifies a path cost to  
14 the root and that seeks to transition a port of the source device to a forwarding state, is-  
15 suing one or more Rapid Transition Acknowledgment messages to the source device,  
16 provided that the specified path cost of the proposal BPDU is lower than the root path  
17 costs associated with the Alternate Stack Root Ports, wherein  
18       the one or more Rapid Transition Acknowledgment messages signal the interme-  
19 diate network device's agreement to the port of the source device transitioning to the  
20 forwarding state.

1       16. The method of claim 15 further comprising the step of issuing a proposal  
2 BPDU message to the source device, provided that the specified path cost of the proposal  
3 BPDU that was received is higher than the root path cost associated with a selected one  
4 of the Alternate Stack Root Ports.

1       17. The method of claim 16 further comprising the step of transitioning the se-  
2 lected Alternate Stack Root Port from a discarding state directly to a forwarding state  
3 provided that the intermediate network device receives a Rapid Transition Acknowledg-  
4 ment message from each device that forms part of the stack.

1       18. The method of claim 17 wherein  
2       the intermediate network device recognizes one or more Virtual Local Area Net-  
3 works (VLANs), and

- 4           the stack port is forwarding for all VLANs recognized by the intermediate net-
- 5   work device.